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Artículo Original

EATING LIKE A GIRL: SEX DIFFERENCES IN THE DIET OF THE LESSER GRISON (*Galictis cuja*) IN SOUTHERN BRAZIL

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ABSTRACT. The lesser grison is a hypercarnivore mustelid that is widespread in South America, inhabiting a large variety of habitats, including steppes, deserts, grasslands, forests, and swamps. However, there are few scientific data on the ecology of the species. In our study, we investigate the feeding habits of the *Galictis cuja* in the Brazilian Pampas by analyzing the stomach contents of road-killed individuals collected from 2013 to 2023. We identify a high consumption of mammals found in 80% of the samples, comprising 75% of the prey consumed. Amphibians, reptiles, and birds are consumed in smaller proportions. Regarding mammals, only rodents were consumed, among which *Cavia* sp., *Holochilus brasiliensis*, and *Rattus* sp. stand out, corresponding to 62% of biomass intake. Although there was no sexual difference in the prey consumed, we found a difference in predation rate, with males consuming more *Rattus* and females consuming more *Cavia*. As a result, males are consuming prey that is proportionally smaller (equivalent to 1/6 of their own weight) than that of females (1/3 of their own weight). This is contrary to what is expected due to the sexual dimorphism of the species; in other mustelids, males consume the larger prey.

RESUMEN. COMENDO COMO UMA MENINA: DIFERENÇAS SEXUAIS NA DIETA DO FURÃO (*Galictis cuja*) NO SUL DO BRASIL. O furão-pequeno é um mustelídeo hipercarnívoro amplamente distribuído na América do Sul, ocorrendo em uma variedade de habitats, incluindo estepes, desertos, campos, florestas e áreas úmidas. Todavia, há poucos dados científicos sobre a ecologia da espécie. Nesse estudo investigamos os hábitos alimentares de *Galictis cuja* na região do Pampa brasileiro, pela análise de conteúdo estomacais de indivíduos encontrados atropelados entre os anos de 2013 e 2023. Identificamos um alto consumo de mamíferos, encontrados em 80% das amostras e compreendendo 75% das presas consumidas. Anfíbios, répteis e aves são consumidos em baixas proporções. No que se refere aos mamíferos, apenas roedores foram encontrados, dentre os quais *Cavia* sp., *Holochilus brasiliensis* e *Rattus* sp. se destacam, correspondendo a 62% da biomassa ingerida. Apesar de não terem sido encontradas diferenças nas presas consumidas por machos e fêmeas, foram encontradas diferenças nos padrões de predação, com machos consumindo mais *Rattus* e fêmeas consumindo mais *Cavia*. Como resultado, machos consomem presas proporcionalmente menores (equivalentes a 1/6 de seu peso) do que as fêmeas (com presas equivalentes a 1/3 de seu peso). Isso é contrário ao esperado dado o dimorfismo sexual de tamanho existente nessa espécie e ao observado em outros mustelídeos, em que os machos consomem presas maiores.

Key words: Feeding habits, trophic niche, Pampas, Carnivora, Rodentia.

Palabras clave: Hábitos alimentares, nicho trófico, Pampa, Carnivora, Rodentia.

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INTRODUCTION

The diet of a species is the most essential feature of its ecology (Castro & Emmons 2012). Studies of alimentary ecology provide a better understanding of other aspects, such as habitat use, prey selection, and ecological niche. A characteristic so central to the life of the animal is related to many other features, such as anatomical and morphological adaptations, behavior, and evolutionary aspects (Eisenberg 1989; Castro & Emmons 2012). Among mammals, carnivores show variable diets and form guilds that include omnivorous, frugivorous, invertebrate eaters, and vertebrate specialists (Kasper et al. 2016). Specialist carnivores such as felids and some mustelids are especially important due to their role as top predators, regulating the prey populations (Errington 1956; Krebs et al. 1995).

The lesser grison (*Galictis cuja*) inhabits a large variety of habitats, including deserts, grasslands, forests, and swamps, from Southern Peru and Bolivia to Southern Brazil, Uruguay, Central Argentina, and Chile (Yensen & Tarifa 2003). The species is relatively tolerant to anthropized environments (Hunter & Barrett 2018) and is a unique terrestrial mustelid in the Brazilian Pampas. It is a poorly known species with few studies on its ecology. The lesser grison is the second least known carnivore species in Brazil, behind the Amazonian weasel (*Mustela africana*) (Oliveira 2009). Most studies on the lesser grison address topics of geographic distribution, habitat use, and morphology (Bornholdt et al. 2013; Poo-Muñoz et al. 2014; Schiaffini 2016; Migliorini et al. 2020). Food habitat was briefly evaluated in some timely studies that classified the species as specialized carnivorous, trophically grouped with felids in Southern Brazil (Kasper et al. 2016) or with canids in other parts of its distribution (Ebensperger et al. 1991; Zapata et al. 2007). The species presents a hypercarnivore diet based on the consumption of rodents, complemented by other items in smaller proportions, such as birds, reptiles, and amphibians (Kasper et al. 2016) or even fruit (Schmitt & Favretto 2021). The lesser grison could act as a key species in the populational dynamic of some species, such as cavies (Kraus & Rödel 2004), and can explore exotic species (such as the introduced lagomorphs) as its main food if available (Buenavista & Palomares 2018). Notwithstanding these interesting roles and food web interactions, few studies are focusing specifically on the diet of this species.

With this scenario, the present study aims to describe the diet of *G. cuja* based on individuals collected in the Brazilian Pampas on the southern border of Brazil. We also test the existence of a difference in the predation patterns of males and females, as sexual dimorphism in size is common in the mustelid family (Wilson & Mittermeier 2009), which is tested for the lesser grison.

MATERIALS AND METHODS

Study area

The study was conducted in the Brazilian Pampas on the southern border of Brazil, occupying 63% of the state of Rio Grande do Sul. The Brazilian Pampas is part of the Uruguayan savanna (Dinerstein et al. 1995) in the Southern Temperate Grasslands of the Pampas (Olson et al. 2001). The climate is classified as *Cfa* by the Koppen-Geiger system, characterized by warm wet summers, cold winters, and well-distributed rainfall over the year (Peel et al. 2007).

The vegetation of the Brazilian Pampas is predominantly composed of grasslands (Buriol et al. 2019), with riparian forests developing along watercourses and forested patches in areas of more pronounced relief (Robaina et al. 2020). Plant diversity is associated with soil, relief, and hydrography characteristics, with grasses having more than 400 species (Boldrini 2009). Due to its characteristics, the Brazilian Pampas is historically used for cattle ranching, resulting in habitat alterations and the maintenance of an open environment by suppressing the development of shrubs and small trees (Bencke et al. 2016). This grassland maintenance is probably beneficial for species well adapted to open environments, such as *G. cuja*, but its impact is poorly understood for many other species.

Diet analysis

The diet of the lesser grison was evaluated by analysis of stomach contents collected from road-killed individuals. Individuals were found opportunistically from 2013 to 2023, along the main roads that cross the Brazilian Pampas in the state of Rio Grande do Sul, such as BR 158, BR 290, BR 293, and BR 392. There is no estimate of sample effort in the collection of individuals because this occurs during trips and displacements in the region. If the individual was found in good conditions, the entire carcass was taken to the Laboratory of Bird and Mammal Biology (LABIMAVE) to be included in the collection of the Pampas Zoology Museum (MZPAMPA). For such individuals, morphological measures were taken, and we collected stomach contents and samples of tissue, cranium, and skin as appropriate. For fragmented individuals and those found in poorly preserved condition, the stomach contents were collected directly from the carcasses in the field. All stomach contents were stored and conserved with 70% alcohol for

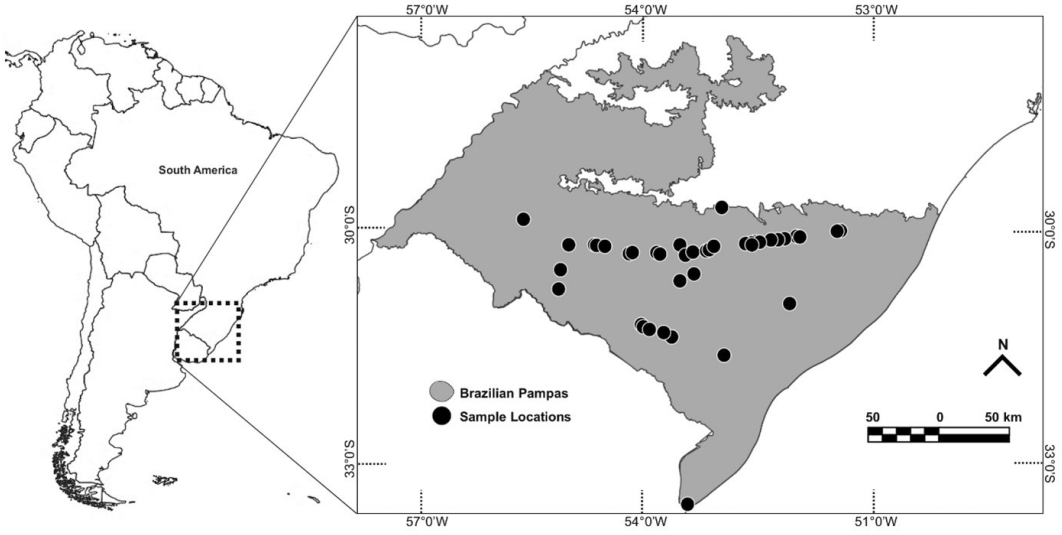

Fig. 1. Map of the *Galictis cuja* sampled for study of their food habits in the Brazilian Pampas.

further analysis in the laboratory. The locations of the individuals included in this study are shown in **Figure** 1, with the geographical coordinates presented in Table S1 as Supplementary Material.

In the laboratory, the stomach contents were washed in running water over a 0.5 mm mesh, separating the non-digested insoluble material. Macroscopic material, such as hair, bones, teeth, and beaks, was analyzed and identified to the lowest possible taxonomic level of prey consumed. Mammal prey was mainly identified by microscopic guard hair patterns using the identification key for Brazilian Pampas rodents of Migliorini et al. (2017).

Any item found in the diet is attributed to a mass, which allows us to estimate the biomass intake. To determine the biomass consumed, we use the mean mass of the item, the minimal number of individuals consumed (MNI), and the maximum amount of feed consumed per day (MAF). The mean mass of the prey was defined using a bibliographic reference or weighting individuals of reference collections with a scale of 0.1 g precision: for mammals, we used Paglia et al. (2012); for amphibians, we used Toledo et al. (2008) and specimens of the Amphibians and Reptiles Collection of the Universidade Federal de Santa Maria (UFSM); and for reptiles and birds, we considered the MAF as a reference biomass intake.

The MAF was defined as 120 g per kg per day. This value was based on Bleavins & Aulerich (1981), who estimated this consumption for *Mustela vision* and *M. putorius*, which are similar species to *G. cuja* in terms of size and ecology. By considering this rate of consumption, we estimate the MAF for males and females, taking into account the morphological data of the individuals included in this study and specimens of the MZPAMPA collection of the Universidade Federal do Pampa (UNIPAMPA). The mean mass (and standard deviation) of males and females is presented in the Results, along with the respective estimate of daily consumption of food. We use ANOVA to test the significance of the sexual dimorphism in size.

Descriptive indexes and statistical analysis

After identification of the items present in the diet, we estimate the MNI. For this estimate, we used body parts that could not generate ambiguity, always considering the consumption of just one individual in case of any doubt. Food items were quantified in terms of frequency of occurrence (FO), expressed by the proportion of stomachs containing each item (Hyslop 1980), and portion of occurrence (PO), expressed by the amount of each food item (number of specimens of a taxon) in relation to the sum of all food items (specimens) found in all diets (Klare et al. 2011). The contribution of each item in the diet was estimated by the proportion of biomass consumed (PBC), which represents the proportion of each taxon (item) to the total biomass intake. In this estimate, we considered the MAF for males and females for each sample (stomach content). In cases of more than one item consumed (different taxa), we considered the consumption of small to bigger prey, respecting the MAF. In cases when the sum of the mean mass of prey exceeded the MAF, we considered the consumption of the entire small prey and the partial consumption of bigger prey, following Kasper & Migliorini (2023).

The difference in prey size between males and females was analyzed using the Mann-Whitney test, based on the mean mass of the main prey in the diet (excluding occasional items). These analyses were done only for individuals of known sex, excluding specimens where there was no record of the sex. For discussion, we considered the proportion of the mean prey size of males and females in relation to their own mass.

RESULTS

We analyzed the stomach contents of 40 *G. cuja*: 20 males, 15 females, and five of unknown sex. The mean mass of 22 individuals was 1.518 kg (± 457 g).

However, there was a significant difference in size (F = 44, 46; p < 0.01), with males weighing 1.826 kg (± 290 g) (n = 13) and females weighing 1.072 kg (± 210 g) (n = 9). Based on this mass, the MAF was estimated at 219 g for males and 129 g for females.

The general diet was composed of mammals, present in 80% of stomach contents and corresponding to 75% of items consumed. Amphibians, reptiles, and birds were consumed in smaller proportions, representing a smaller proportion of consumed items.

Among mammals, which were the main prey, all the taxa identified were small rodents. The consumption of rodents corresponded to 77.4% of total biomass intake by *G. cuja*. The most frequently consumed species was *Cavia* sp., found in 35% of the stomach contents and corresponding to 30% of all prey rodents. Considering just the rodents, the species more representative of the diet were *Cavia* sp., *Holochilus brasiliensis*, and *Rattus* sp., corresponding to more than 62% of the biomass intake (**Table** 1). Although other rodents were consumed relatively frequently, their contribution to the biomass consumed is smaller due to their small size.

Although males and females prey on basically the same species, they consume their prey in different proportions. Males consume more *Rattus* sp., whereas females consume more *Cavia* sp. (**Fig**. 2). The mean size of the prey consumed by *G. cuja* in southern Brazil was 287 g, with no statistical differences between males and females (z = 1.486; p = 0.13729). However, if we consider the proportion of the size of the prey in relation to the mean size of males and females, we find an important difference: males consume prey of size 264.8 g (± 185.7 g), which corresponds to 14.5% of its own size (or 1/6 of its mass); and females consume prey of size 376.8 g (± 213.1 g), which corresponds to 35.1% of its own size (or 1/3 of its mass).

DISCUSSION

We reveal a specialized diet for the lesser grison in Southern Brazil based on small vertebrates, especially small rodents, corroborating previous studies (Ebensperger et al. 1991; Delibes et al. 2003; Kraus & Rödel 2004; Zapata et al. 2005; Kasper et al. 2016). Another similarity with the scientific literature found in our study was the mean size of the prey, described by Ebensperger et al. (1991) as 350 g, which is a value close to that observed in southern Brazil (287 g). However, several studies in Chile and Argentina point to hares and rabbits (introduced lagomorphs) as the main food of the species (Delibes et al. 2003; Zapata et al. 2005), which was not the case in our study.

Even with an eightfold difference in size, *G. cuja* presents niche overlap with *Pseudalopex culpaeus* when they occur in sympatry due to the high rate of mammal consumption, especially rodents (Ebensperger et al. 1991). However, this canid presents more diversified food habits in Chile and Argentina, including more invertebrates and vegetal material (Ebensperger et al. 1991; Zapata et al. 2007), compared with other foxes in Brazil (Bossi et al. 2018). In our study, *G. cuja* is included in a more diversified assemblage of carnivores and overlaps its alimentary niche with small felids (Kasper et al. 2016), similar to what was observed by Zapata et al. (2007) in Argentinean Patagonia. This overlap is related to high rates of rodent consumption and highlights the importance of multispecies studies to investigate the mechanisms of interaction and coexistence of these carnivores.

Rodents are the main food of *G. cuja* in many studies, particularly in the Brazilian Pampas. The importance of this kind of food is even more relevant considering its contribution to biomass intake, which is more than 75% of all the food consumed. This value is similar to those reported by Delibes et al. (2003) and Zapata et al. (2007), at 49.2% and 56.0%, respectively. Our data are even more similar to those for Uruguay, where the diet of the species is reported as almost exclusively rodents (Kraus & Rödel 2004). The predominance of rodents is related to the absence of lagomorphs in our study, a group present in 20.9-60.3% of the samples in the Argentinean Patagonia (Delibes et al. 2003).

More than frequency of occurrence, rodents constitute the main part of biomass intake, especially larger species such as *Cavia* sp., *Holochilus brasiliensis*, and *Rattus* sp. These three species correspond to 62% of all biomass consumed, similar to what was reported by Ebensperger et al. (1991). In Uruguay, cavies are the main food when available, being replaced by *H. brasiliensis* and *Scapteromys tumidus* when *Cavia* becomes scarce (Kraus & Rödel 2004). Although some small rodent species, such as *Calomys laucha*, are frequent in the diet reported in our study, they make little contribution to biomass intake. This agrees with Kraus & Rödel (2004), who report a small consumption of *Akodon*, one of the most common rodents in the Uruguayan savanna (personal observation), suggesting a tendency to forage for larger rodents. This is interesting because the diet of *Leopardus geoffroyi*, a wildcat twice as big as the lesser grison and sympatric in the Pampas

Table 1
List of prey found in the diet of *Galictis cuja* in the Brazilian Pampas, with the mean mass of each taxon. MNI: minimal number of individuals consumed; FO: frequency of occurrence; PO: proportion of occurrence; PBC: proportion of biomass consumed.

Taxon	MNI	FO	PO	PBC	
				General	(males/females)
Amphibia (general)		22.5%	0.14	0.038	0.035/0.044
Leptodactylus latrans (30 g)	1	2.5%	0.02	0.005	-/0.018
Rhinella dorbignyi (19 g)	1	2.5%	0.02	0.003	-/0.011
Unidentified amphibian (25 g)	7	17.5%	0.11	0.030	0.035/0.015
Reptilia (general)		10%	0.06	0.115	0.115/0.154
Salvator merianae (3,500 g*)	1	2.5%	0.02	0.022	-/0.077
Bothrops alternatus (353 g*)	1	2.5%	0.02	0.037	0.061/-
Unidentified reptile (*)	2	5.0%	0.03	0.055	0.054/0.077
Aves (general) (*)	3	8%	0.05	0.073	0.092 / 0.059
Mammals/Rodentia (general)		80%	0.750	0.774	0.757/0.744
Cavia sp. (549 g*)	14	35.0%	0.222	0.325	0.261/0.489
Akodon sp. (32 g)	2	5.0%	0.032	0.011	0.009/0.019
Calomys laucha (19 g)	9	17.5%	0.143	0.007	0.027/0.011
Deltamys kempi (26 g)	1	2.5%	0.016	0.004	0.007/-
Holochilus brasiliensis (238 g*)	6	15.0%	0.095	0.160	0.153/0.153
Lundomys molitor (280 g*)	1	2.5%	0.016	0.019	0.031 -
Necromys lasiurus (60 g)	3	7.5%	0.048	0.031	0.017/0.071
Oligoryzomys sp. (20 g)	2	5.0%	0.032	0.007	-/- †
Oxymycterus nasutus (50 g)	3	7.5%	0.048	0.026	0.028/-
Sooretamys angouya (140 g*)	2	2.5%	0.032	0.026	-/- †
Rattus sp. (270 g*)	4	10.0%	0.063	0.137	0.225/-

Taxonomic sequence of mammals following Abreu et al. (2023). * Biomass intake limited to the maximum amount of feed consumed per day (MAF) by *Galictis cuja*; mass of *Rhinella dorbignyi* estimated from the mean of six individuals of the Amphibians and Reptiles Collection of the Universidade Federal de Santa Maria (UFSM); mass of "Unidentified amphibian" estimated from the mean of the other taxa identified in the diet; mass of *Bothrops alternatus* estimated from the mean of seven individuals of the zoological collections of Universidade Federal do Pampa (UNIPAMPA); mass of *Rattus norvegicus* in rural areas of Argentina (Villafañe et al. 2013). † Items that occur only in individuals with indeterminate sex.

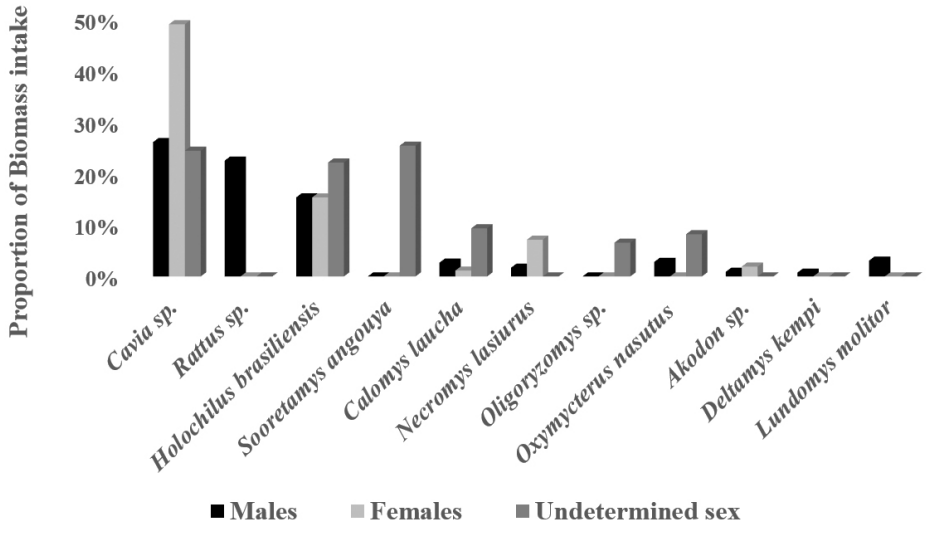

Fig. 2. Proportion of biomass consumed by *Galictis cuja* in the Brazilian Pampas: comparison of the consumption of males and females (and individuals without sex identification).

grasslands, includes several small rodents, such as *Oligoryzomys*, in higher proportions than *Cavia* (Tirelli et al. 2023).

Forage for larger species is in accordance with the Optimal Foraging Theory (MacArthur & Pianka 1966), which postulates a preference for predation prey that represents a better cost-benefit ratio between capture and energy gain. However, based on this theory, the consumption of other larger prey in other locations, such as lagomorphs, would be expected in our study too. The consumption of lagomorphs seems related to the availability, particularly of *Oryctolagus cuniculus* (Diuk-Wasser & Cassini 1998), and corresponds to the main prey in Patagonia and Chile (Ebensperger et al. 1991; Diuk-Wasser & Cassini 1998). Although common in the Brazilian Pampas (Christoff 2003) and reaching high abundance in some localities (Kasper et al. 2012), the European hare (*Lepus euroupaeus*) was not found in the diet of *G. cuja* in our study. Similarly, Sadi et al. (2012) did not find *L. europaeus* in the diet of the lesser grison, despite the availability of this resource in their study areas. On the other hand, we find the consumption of other introduced species, with the frequent record of *Rattus* in the diet. In this way, several authors (Ebensperger et al. 1991; Diuk-Wasser & Cassini 1998; Delibes et al. 2003; Zapata et al. 2005) highlight the potential role of *G. cuja* in the control of invasive species.

There are no good studies on the abundance of small mammals (rodents in particular) in the Brazilian Pampas. Thus, we cannot address the availability of this prey for *G. cuja*. In this paper, we only discuss consumption patterns and assume that availability is the same for both males and females. In this comparison, we find what is probably the most striking conclusion: that the females, which are significantly smaller than the males, consume proportionally larger prey. This is the first approach to the subject of *G. cuja* because most of the previous studies were based on feces, which makes it difficult to identify the sex of the animal. Although no statistically significant difference was found in the prey size of males and females, there was an important difference in prey habits: females prey on rodents that are 1/3 of their own mass, and males prey on rodents that are 1/6 of their own mass. This is interesting because in other similar mustelids, such as *Neovison vison* (Birks & Dunstone 1985; Magnusdottir et al. 2012) and *Mustela putorius* (Zalewsky et al. 2021), larger prey is consumed by the males, as expected. A possible explanation could be related to the higher energetic demand of females, especially during breeding. In our sample, two females were in the reproductive period: one pregnant and the other nursing. Our observation suggests that females breed alone, without male contribution, which explains several direct sightings

of a female foraging with several juveniles of similar size to the adults (Trigo et al. 2013). Our hypotheses are in line with the data of Kraus & Rödel (2004), finding the consumption almost exclusively of *Cavia* during the summer, coinciding with the observation of juveniles in the study area. However, this is just a speculative hypothesis, and further observations are necessary for a proper assessment of the subject. We cannot assess the availability of rodents in the environment because our samples cover more than 150 000 km² of the Brazilian Pampas. However, we believe that the variation in rodent availability is similar for males and females, with small differences according to specific environments. Therefore, the difference in the consumption patterns of males and females seems related to its ecology and not a reflection of environmental differences.

The difference in the proportional prey size for females is mostly related to higher consumption of *Cavia*, the larger rodent identified in the diet of the species in our study. The consumption of this taxon is the focus of the study by Kraus & Rödel (2004) in Uruguay and shows that *G. cuja* acts as the main predator controlling the population of this rodent. In our study, the consumption of *Cavia* was more intense by females, with the males consuming more *Rattus*. In light of this, we can suggest that males and females forage using different strategies. It is plausible to expect that males forage for rodents either burrowed or in the nests, whereas females could hunt more actively, featuring the known scenes of the lesser grisons chasing cavies, as described by Silva (2014) and Trigo et al. (2013). Another possibility is a temporal difference in the activity, with females foraging more during the day when *Cavia* is more active (Furnari 2011) and males foraging at night when most of the other rodents are more active. However, once again, this is conjecture because almost nothing is known about the behavior of *Galictis*, and even less about the potential differences between males and females.

New studies monitoring individuals using telemetry could help to elucidate several questions regarding the ecology and behavior of the lesser grison. Our study has produced relevant data on the feeding ecology of this species, which has been little known until now. We hope that this study incites new investigations into this fascinating carnivore.

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ONLINE SUPPLEMENTARY MATERIAL

Table S1